7. ECS RMA Modeling Process

7.1 Model Implementation Overview

The ECS availability models have been implemented using Excel 5.0 workbooks. The models consist of a series of linked workbooks and workbook pages (worksheets) that accept user's inputs, calculate individual equipment availability as well as functional HWCI group availability, and display the results in tabulated and graphical formats using equations described in Section 6. This process also allows the user to exercise "what-if" scenarios so that the reliability analysis results can be timely fed back to the designers and logistics personnel for the performance of trade studies.

7.1.1 Modeling Description

For the FOS Release A/B and SDPS/CSMS Release B CDRs there are a total of eight (8) workbooks that are being used to support the ECS availability modeling task. These are the FOS, LaRC, GSFC, EDC, JPL, NSIDC, ORNL, and ASF Release B CDR workbooks. Each workbook contains approximately thirty (30) worksheets consisting of the results summary table, site input tables, subsystem tables, functional requirement tables, and block diagrams.

The site input table is the heart of the ECS availability model. This table is the main database that contains all pertinent RMA information such as the equipment's description, part number, MTBF, MTTR, ALDT, MDT, Switchover Time, Total Number of Units in the system, Number of Required Units for functional success, redundancy configuration and the switchover probability. From the Inputs table, each Subsystem table and functional requirements table was formed by extracting the subsystem's and function's associated HWCIs, respectively. Then from these tables the block diagrams were generated. Figure 7.1.1-1 shows the general ECS Availability Models database structure and the worksheets relationship. The worksheets are linked within the workbook and the workbooks are also linked to the Results Summary Table in the RB_LaRC workbook.

7.1.2 Input Table Description

The Input Table worksheets provides a mechanism for user’s inputs, computes the availability of each equipment, subsystem and function and forwards the input and results to the other worksheets for display or archival. These input worksheets will accept user’s inputs such as: the equipment’s part number, MTBF, MTTR, ALDT, switchover time, number of units available, number of units that are allowed to fail, type of subsystem redundancy, and the probability of switching when a given unit fails. The functional availability and MDT results are displayed at the bottom of the corresponding worksheet. Figure 7.1.2-1 shows a sample of the Input Table worksheet at the Release B LaRC site. Appendix A provides a detailed description of the worksheet headings.

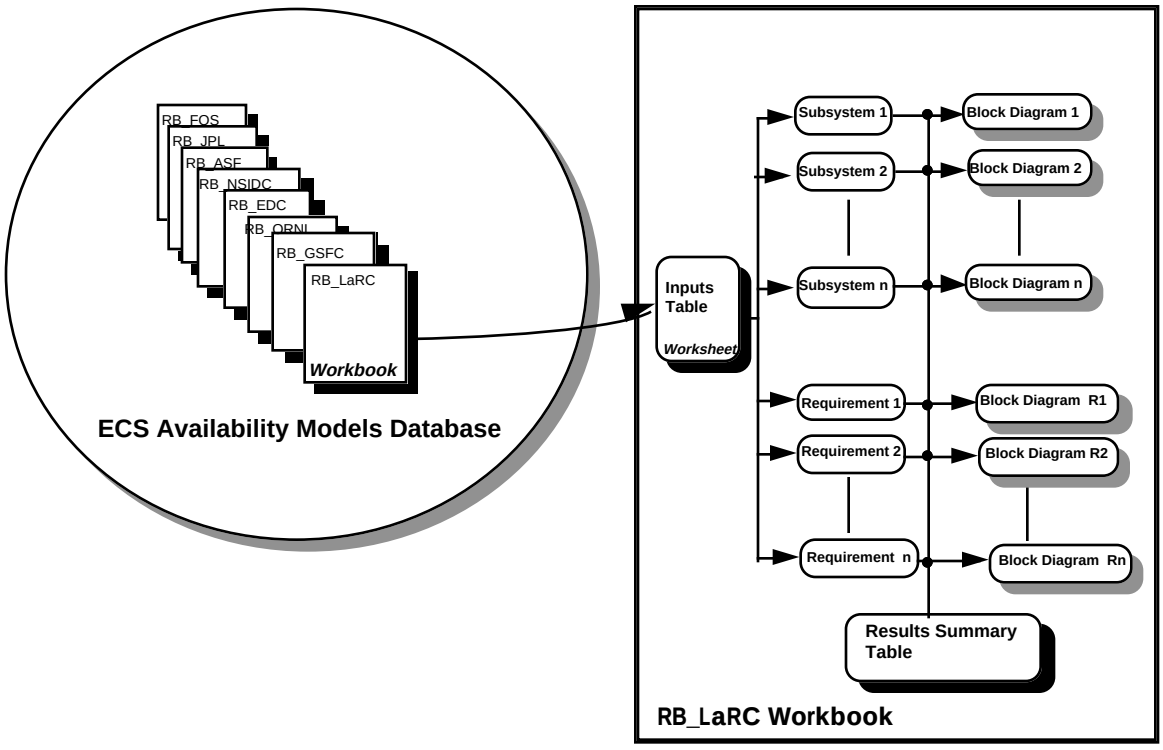

Figure 7.1.1-1. ECS Availability Model Database Structure

7.1.3 Reliability Block Diagram Description

The availability models for the required ECS functions are graphically presented as block diagrams in Appendix A in conjunction with the functional worksheets.

The availability (A_G) value, shown on the top of each equipment's block, is the group availability for the redundant units. For a single unit, A_G is equal to Ai which is the unit availability. The redundant configuration is shown in the upper right corner box. The MTBF, MTTR, Ai, ALDT, Downtime, and Switchover time values for each equipment, and redundant group, are displayed below each corresponding equipment and redundant group as shown in Figure 7.1.3-1.

Release	Site	Subsystem Description	Equipment Description	Model/Part Number	MTBF (hour)	MTTR (hour)	Admin. Logistic Delay Time (hour)	Switchover Time (min)	Total Downtime (hour)	Number of Units Required (m)	Total Number Of Units (n)	Redundancy	Unit Availability (Ai)	P	Redundant Group Availability (m out of n)
B	LaRC	Data Manag.	DMG SERVER	K400, 2 CPU, 512 MB RAM, 8 GB, 8 mm	22,747	2.7	6	N/A	8.70	1	1	N/A	0.9996177	N/A	0.9996177
B	LaRC	Data Manag.	RAID DISK	HP 10 GB	150,000	0.5	6	N/A	6.50	1	1	N/A	0.9999567	N/A	0.9999567
B	LaRC	Data Manag.	DATA SPECIALIST W/S	SUN Sparc 20/50, 64 MB RAM, 6 GB	15,947	0.5	6	5.00	6.50	1	3	standby off-line	0.9995926	1.0	1.0000000
B	LaRC	Data Manag.	DBA OPS WORKSTATION	HP 715/64, 64 MB RAM, 6 GB	37,300	1.0	6	N/A	7.00	1	1	N/A	0.9998124	N/A	0.9998124
B	LaRC	Ingest	RAID	SGI 102 GB RAID	150,000	0.5	6	N/A	6.50	1	1	N/A	0.9999567	N/A	0.9999567
B	LaRC	Ingest	INGEST SVR/8mm Drives	SGI Challenge L, 4 CPU/3 8mm drives	6,444	1.5	6	5.00	7.50	1	2	standby off-line	0.9988375	1.0	1.0000000
B	LaRC	Ingest	X TERMINAL	X TERMINAL, NCD HMX Pro, 16 MB RAM	27,548	0.5	6	N/A	6.50	1	1	N/A	0.9997641	N/A	0.9997641
B	LaRC	Ingest	ARCHIVE ROBOTICS	ARCHIVE ROBOTICS - 1 Tower, 1 Arm	7,012	1.0	6	N/A	7.00	1	1	N/A	0.9990027	N/A	0.9990027
B	LaRC	Ingest	LINEAR MAG DR	NTP Linear Tape Drive, 3590	10,000	1.0	6	15.00	7.00	1	2	standby off-line	0.9993005	1.0	0.9999999
B	LaRC	Ingest	INGEST SERVER	SGI Indigo2, 256 MB RAM, 6 GB	4,684	1.0	6	N/A	7.00	1	1	N/A	0.9985078	N/A	0.9985078
B	LaRC	Ingest	INGEST SERVER	SGI Challenge DM, 256 MB RAM, 4 GB	5,914	1.5	6	N/A	7.50	1	1	N/A	0.9987334	N/A	0.9987334
B	LaRC	ACM	APC SERVER	SGI Challenge L, 4 CPU, 256 MB RAM, 4 GB	6,714	1.5	6	5.00	7.50	1	2	standby off-line	0.9988842	1.0	0.9999999
B	LaRC	ACM	RAID DISK	340 GB	150,000	0.5	6	N/A	6.50	1	1	N/A	0.9999567	N/A	0.9999567
B	LaRC	ACM	OPS WORKSTATION	Sun Sparc 20/50, 64 MB RAM, 4 GB	15,947	0.5	6	5.00	6.50	1	2	standby off-line	0.9995926	1.0	1.0000000
B	LaRC	DIP	DISTRIBUTION SERVER	SUN Sparc 20/712, 256 MB RAM, 6 GB	3,752	1.0	6	5.00	7.00	1	1	standby off-line	0.9981378	1.0	0.9999998
B	LaRC	DIP	RAID DISK	240 GB	150,000	0.5	6	N/A	6.50	1	1	N/A	0.9999567	N/A	0.9999567
B	LaRC	DIP	TAPE STACKER	3, 8mm Drives w/stacker - Exabyte	160,000	0.3	6	N/A	6.25	1	1	N/A	0.9999609	N/A	0.9999609
B	LaRC	DIP	TAPE STACKER	3, 4mm Drives w/stacker - Exabyte	146,000	0.5	6	N/A	6.50	1	1	N/A	0.9999555	N/A	0.9999555
B	LaRC	DIP	CD ROM	CD ROM, Recordable, JVC	14,598	0.5	6	N/A	6.50	1	1	N/A	0.9995549	N/A	0.9995549
B	LaRC	DIP	FAX/SCANNER	FAX/SCANNER	5,000	0.5	6	N/A	6.50	1	1	N/A	0.9987017	N/A	0.9987017
B	LaRC	DIP	TAPE DRIVE	3480/3490 TAPE DRIVE	35,000	0.5	6	N/A	6.50	1	1	N/A	0.9998143	N/A	0.9998143
B	LaRC	DIP	TAPE DRIVE	6250 BPI Tape Drive	16,717	1.0	6	N/A	7.00	1	1	N/A	0.9995814	N/A	0.9995814

Figure 7.1.2-1. Sample of Input Table Worksheet at LaRC Site

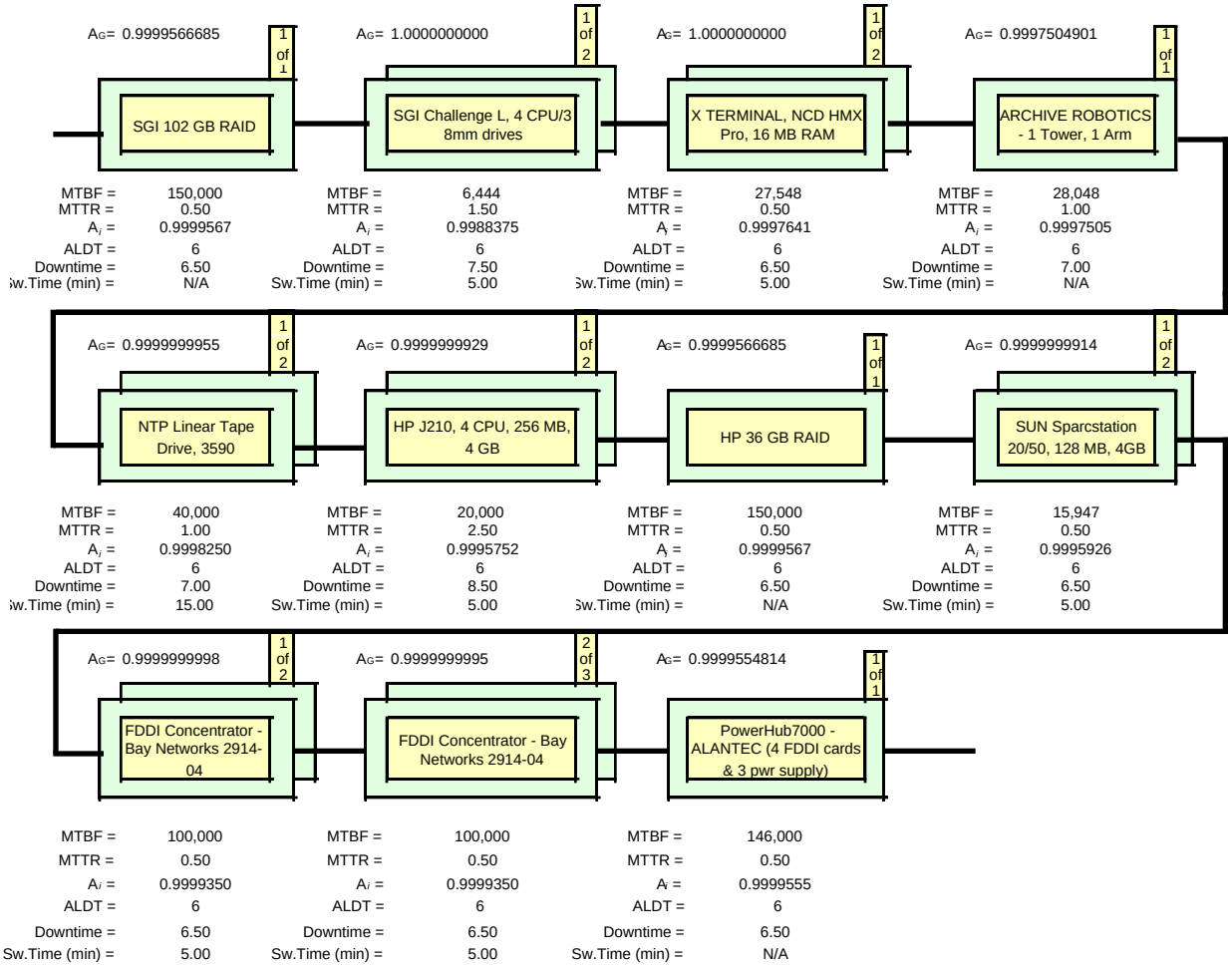

Figure 7.1.3-1. Sample of a Reliability Block Diagram at LaRC Site.

8. Summary of ECS Availability Results

The following table summarizes the availability (A_O) and MDT results for all ECS required functional availabilities at LaRC, NSIDC, GSFC, JPL, ORNL, EDC, and ASF sites. These results were obtained from the analytical availability models presented in Appendix A which reflect the SDPS/CSMS Release B CDR physical architecture. FOS results remain unchanged from the previous submittal.

As shown from the table below, all quantitative RMA requirements for the ECS and its Segments, at the Release B Critical Design Review (CDR) time frame, have achieved their required values. As the ECS system design evolves, these availability and MDT computations will be evaluated and updated throughout the program's life cycle.

Table 8-1. A_O/MDT Required vs Predicted Values at LaRC, NSIDC and GSFC

Req't Nos. (Ao/MDT)	LaRC		NSIDC		GSFC	
	Ao	MDT (hrs)	Ao	MDT (hrs)	Ao	MDT (hrs)
EOSD3700 (>0.96/<4.0 hrs)	0.9922974	0.78	0.9980234	1.52	0.9930703	2.03
EOSD3900 (>0.999/2.0 hrs)	0.9996638	0.93	N/A **	N/A **	0.9997071	1.55
EOSD3920 (>0.98/<2.0 hrs)	0.9979736	0.88	0.9984500	1.02	0.9942315	1.78
EOSD3930 (>0.993/<2.0 hrs)	0.9998253	0.39	0.9998253	0.45	0.9998253	0.40
EOSD3940 (>0.993/<2.0 hrs)	0.9998687	0.44	0.9998687	0.44	0.9998687	0.44
EOSD3950 (>0.993/<2.0 hrs)	0.9999721	0.67	0.9999721	0.67	0.9999721	0.67
EOSD3960 (>0.96/<4.0 hrs)	0.9997818	0.34	0.9997819	0.34	0.9997819	0.34
EOSD3970 (>0.96/<4.0 hrs)	0.9998253	0.39	0.9998253	0.40	0.9998253	0.40
EOSD3980 (>0.96/<4.0 hrs)	0.9998687	0.44	0.9998687	0.44	0.9998687	0.54
EOSD3990 (>0.96/<4.0 hrs)	0.9998687	0.44	0.9998687	0.44	0.9998687	0.44
EOSD4000 (>0.96/<4.0 hrs)	0.9998687	0.45	0.9999121	0.68	0.9999121	0.68
EOSD4010 (Ao > 0.95)	0.9978210	N/A	0.9978210	N/A	0.9978210	N/A
EOSD4030 (>0.998/<20 Min)	N/A*	N/A*	N/A*	N/A*	0.9999121	0.08

* SMC Function Is Only Applied At GSFC

** No L0 Ingest at NSIDC

Table 8-2. A_O/MDT Required vs Predicted Values at JPL, ORNL, EDC, and ASF

Req't Nos. (Ao/MDT)	JPL		ORNL		EDC		ASF	
	Ao	MDT (hrs)	Ao	MDT (hrs)	Ao	MDT (hrs)	Ao	MDT (hrs)
EOSD3700 (>0.96/<4.0 hrs)	0.9964327	2.43	N/A*	N/A*	0.9911990	1.21	N/A*	N/A*
EOSD3900 (>0.999/2.0 hrs)	0.9996638	0.93	N/A*	N/A*	0.9999133	0.32	N/A*	N/A*
EOSD3920 (>0.98/<2.0 hrs)	0.9977346	1.42	0.9971192	1.26	0.9958588	1.36	0.9971192	1.26
EOSD3930 (>0.993/<2.0 hrs)	0.9998253	0.36	0.9975509	1.60	0.9998253	0.36	0.9975509	1.60
EOSD3940 (>0.993/<2.0 hrs)	0.9998687	0.39	0.9998686	0.34	0.9998687	0.39	0.9998686	0.34
EOSD3950 (>0.993/<2.0 hrs)	0.9999721	0.67	0.9999721	0.67	0.9999721	0.67	0.9999721	0.67
EOSD3960 (>0.96/<4.0 hrs)	0.9997819	0.37	0.9975076	1.33	0.9997819	0.37	0.9975076	1.33
EOSD3970 (>0.96/<4.0 hrs)	0.9998253	0.36	0.9975509	1.46	0.9998253	0.39	0.9975509	1.46
EOSD3980 (>0.96/<4.0 hrs)	0.9998687	0.39	0.9998686	0.34	0.9998687	0.39	0.9998686	0.34
EOSD3990 (>0.96/<4.0 hrs)	0.9998687	0.39	0.9998686	0.34	0.9998687	0.39	0.9998686	0.34
EOSD4000 (>0.96/<4.0 hrs)	0.9998687	0.45	0.0000000	1.00	0.9998687	0.45	0.9973568	2.22
EOSD4010 (Ao > 0.95)	0.9978210	N/A	0.9978210	N/A	0.9978210	N/A	0.9978210	N/A

* There are no data products processing and L0 ingest at ORNL and ASF